

Docket No.: 020732-100.686
Appl. No.: 10/724,791

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Section II. (REMARKS)

The pending claims are 1, 5-7, 9, 11-14, 39, 41 and 42.

Amendment of Claims 1 and 39

Claims 1 and 39 have been amended to change the transition phrase from "consisting essentially of" to "consisting of," without prejudice. In addition, the limitation of previously pending claim 4 has been added to both claims 1 and 39. Accordingly, the Examiner has considered all of the teachings of the pending claims and no new search is needed.

Rejection of Claims on Reference Grounds, and Traversal Thereof

In the July 13, 2007 Office Action:

claims 1, 4, 5, 7, 9, 14 and 39-42 were rejected under 35 U.S.C. §103(a) as being unpatentable over Sehgal (U.S. Patent Application Publication No. 20040050406);

claim 6 was rejected under 35 U.S.C. §103(a) as being unpatentable over Sehgal in view of Mullee (U.S. Patent No. 6,306,564); and

claims 11-13 were rejected under 35 U.S.C. §103(a) as being unpatentable over Sehgal in view of Wilkinson et al. (U.S. Patent No. 5,789,505).

These rejections are traversed in application to the claims as amended herein. The patentable distinctions of the amended claims over the cited references are set out in the ensuing discussion.

Rejections under 35 U.S.C. §103(a)

1. In the July 13, 2007 Office Action, claims 1, 4, 5, 7, 9, 14 and 39-42 were rejected under 35 U.S.C. §103(a) as being unpatentable over Sehgal (U.S. Patent Application Publication No. 20040050406). Applicants traverse such rejection.

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Claim 1 has been amended to recite:

“An etching composition consisting of a supercritical fluid (SCF), at least one co-solvent, and at least one etchant species, wherein the co-solvent consists of at least one straight-chained or branched C₁-C₆ alcohol and the etchant species consists of at least one bifluoride compound selected from the group consisting of ammonium bifluoride and tetraalkylammonium bifluoride ((R)₄NHF₂), wherein R is a C₁-C₄ alkyl group and said composition is adapted for etching a sacrificial silicon-containing layer on a substrate.”
(emphasis showing added limitation(s))

It can be seen that claim 1 has been amended to recite that the etching composition consists of a supercritical fluid (SCF), at least one co-solvent, and at least one etchant species.

Sehgal relates to compositions tailored to selectively attack only the resist and/or residue without attacking the semiconductor device structures¹ (including low-k dielectrics such as SiO₂²) and discloses a “co-solvent 1” mixture which includes one or more organic solvent(s) and may further include any one of an oxidizer, buffering agents, corrosion inhibitors, chelating agents, surfactants, accelerators, or aqueous fluorides. The preferred embodiment includes one or more organic solvents, an oxidizer and an accelerator.

According to the Examiner, Sehgal

“differs in failing to teach the composition “consisting essentially of” or “consisting of” Applicant’s specifically claimed supercritical fluid, at least one co-solvent, and at least one bifluoride compound, as recited in the claims. However, Sehgal illustrates the combination of a supercritical fluid and at least one co-solvent, and an aqueous fluoride, which includes ammonium bifluoride may be added to the co-solvent mixture [0048] or other ingredients in supercritical form may be used alone or in combination with each other or with supercritical CO₂ [0025]. Hence, it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify Sehgal by using any combination of components, including Applicants’ specifically claimed composition because

¹ see, Sehgal, paragraph [0012].

² see, Sehgal, paragraph [0006].

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such components are known to effect the disclosed composition in processing semiconductor substrate since Applicants have failed to provide evidence as to what is actually excluded by "consisting essentially of." (emphasis added)

Applicants vigorously disagree.

As introduced hereinabove, Sehgal relates to the removal of organic materials such as photoresist and/or resist residue without attacking inorganic materials such as low-k films on the semiconductor device structure. In contrast, applicants' composition is formulated to actually etch inorganic materials such as sacrificial silicon-containing layers. Accordingly, there is no reason for one skilled in the art assigned with the task of removing sacrificial silicon-containing materials from a substrate to even consider Sehgal because the desired end results are mutually exclusive of one another. Accordingly, one cannot reasonably expect that sacrificial silicon-containing material may successfully be removed using the teaching of Sehgal.³

In addition, it can be seen that claim 1 has been amended to specifically recite that the at least one co-solvent consists of at least one straight-chained or branched C₁-C₆ alcohol. Notably, the co-solvents disclosed in Sehgal for the "co-solvent 1 mixture" include alcohols, however, none of the alcohols disclosed in paragraph [0029]⁴ include straight-chained or branched C₁-C₆ alcohols, as claimed herein.

The alcohols also referred to in the July 19, 2007 Office Action at page 3, line 12 ("lower alcohols (methanol, ethanol)") are actually taught in the "accelerator" teaching (see, e.g., Sehgal, paragraph [0046]). If the Examiner argues that it is obvious to select JUST the lower alcohols from the list of accelerators and JUST the bifluorides from the list of fluorides, the Examiner will have to provide sufficient reasons to support said suggestion, especially knowing that the end result of the Sehgal teaching and applicants' claimed invention are mutually exclusive. Further, referring to the schematic below, it can be seen that it is not reasonable for one skilled in the art considering the laundry list of compounds disclosed in Sehgal to select JUST the alcohols

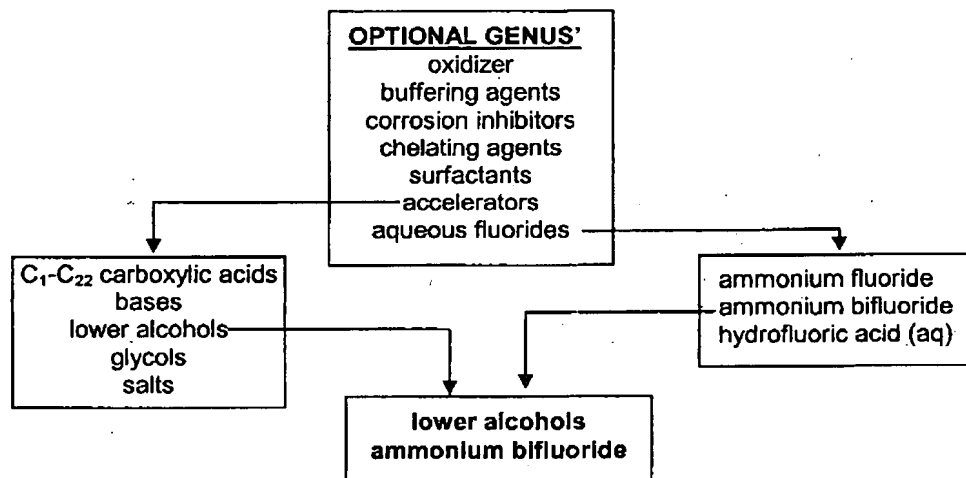
³ See, *In re Rinehart*, 189 U.S.P.Q. 143 (CCPA 1976) (addressing the lack of any reasonable expectation of success as evidencing non-obviousness).

⁴ Benzyl Alcohol, Diacetone Alcohol, Furfuryl Alcohol, Hexylene Glycol, Methylbenzyl Alcohol (all four of its isomers: alpha, ortho, meta and para), Phenoxy Ethanol, Phenoxy Propanol, Propargyl Alcohol, Tetrahydrofurfuryl Alcohol and the like and mixtures thereof.

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from the list of accelerators and **JUST** the bifluorides from the list of fluorides.



In other words, not only **MUST** one skilled in the art select only two of the seven optional genus' for combination with the SCF, then one skilled in the art must select the accelerator PLUS the aqueous fluoride from the list of seven optional genus', and then one skilled in the art **MUST** select the lower alcohols from the list of five possible accelerator sub-species and ammonium bifluoride from the list of three possible aqueous fluoride sub-species. Importantly, there are 21 different combinations of two components based on the seven optional genus'.⁵ Combined with the necessity to select the claimed sub-species, it is not even reasonable that one skilled in the art considering Sehgal would come up with a composition consisting of a SCF, at least one of the recited co-solvents, and at least one of the recited etchant species.

Claim 39 has been amended to recite:

"An etching composition consisting of a supercritical fluid, at least one co-solvent, at least one bifluoride compound, and at least one non ionic surfactant, wherein the co-solvent consists of at least one straight-chain or branched C₁-C₆ alcohol and the at least one bifluoride compound consists of

⁵ combinations = $\frac{n!}{k!(n-k)!}$, where n represents the total number of objects and k represents the size of the combination.

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a species selected from the group consisting of ammonium bifluoride and tetraalkylammonium bifluoride $((R)_4NHF_2)$, wherein R is methyl, ethyl, butyl, phenyl or fluorinated C_1-C_n alkyl groups and said composition is adapted for etching a sacrificial silicon-containing layer on a substrate.” (emphasis showing added limitation(s))

Similarly to claim 1, the end result of Sehgal and applicants’ claimed invention are mutually exclusive of one another. Further, in the case of claim 39, one skilled in the art would have to select only three of the seven optional genus’ for combination with the SCF, then one skilled in the art must select the accelerator PLUS the aqueous fluoride PLUS the surfactant from the list of seven optional genus’, and then one skilled in the art MUST select the lower alcohols from the list of five possible accelerator sub-species and ammonium bifluoride from the list of three possible aqueous fluoride sub-species and non-ionic surfactants from the list of four different sub-species of surfactants (see, e.g., Sehgal, paragraph [0060]). Importantly, there are 35 different combinations of three components based on the seven optional genus’. Combined with the necessity to select the claimed sub-species, it is not even reasonable that one skilled in the art considering Sehgal would come up with a composition consisting of a SCF, at least one of the recited co-solvents, at least one of the recited etchant species, and at least one non-ionic surfactant.

This is not a simple case where there are a finite number of identified, predictable solutions (see, e.g., *KSR International Co. v. Teleflex Inc.*, No. 04-1350 (slip op., April 30, 2007)). If the Examiner feels that it is, then the Examiner must provide “articulated reasoning with some rational underpinning to support the legal conclusion of obviousness.” *Id.*

In conclusion, it is not reasonable for one skilled in the art to consider Sehgal and select just the components in applicants’ claims 1 and 39. Moreover, because the Sehgal teaching is mutually exclusive of the end result of applicants’ claimed inventions, one skilled in the art could not consider Sehgal and reasonably expect to successfully remove silicon-containing materials. Accordingly, applicants request withdrawal of the rejection of claims 1, 4, 5, 7, 9, 14 and 39-42 as being obvious in view of Sehgal.

2. In the July 13, 2007 Office Action, claim 6 was rejected under 35 U.S.C. §103(a) as

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being unpatentable over Sehgal as applied to claim 1, in view of Mullee (US 6,306,564) (hereinafter Mullee). Applicants traverse such rejection.

Claim 6 depends directly from claim 1, which as discussed hereinabove, is non-obvious in view of Sehgal. Mullee does not cure this deficiency.

Similar to Sehgal, Mullee discloses a laundry list of chemical compounds that may be added to the supercritical CO₂ composition of Mullee, including:

“N-Methyl Pyrrolidone (NMP), diglycol amine, hydroxyl amine, tertiary amines, catechol, ammonium fluoride, ammonium bifluoride, methylacetoacetamide, ozone, propylene glycol monoethyl ether acetate, acetylacetone, dibasic esters, ethyl lactate, CHF₃, BF₃, other fluorine containing chemicals, or a mixture of any of the above chemicals. [] Other chemicals such as an organic solvent may be used independently or added to one or more of the above chemicals to remove organic contaminants from the wafer surface. The organic solvent may include, for example, an alcohol, ether, and/or glycol, such as acetone, diacetone alcohol, dimethyl sulfoxide (DMSO), ethylene glycol, methanol, ethanol, propanol, or isopropanol (IPA).” (see, Mullee, col. 4, lines 12-36)

Importantly, like Sehgal, Mullee relates to the removal of organic materials such as photoresist, resist residue, and/or organic contaminants from the surface of a semiconductor wafer. Accordingly, there is no reason for one skilled in the art assigned with the task of removing sacrificial silicon-containing materials from a substrate to even consider Mullee (or Sehgal) because one cannot reasonably expect that sacrificial silicon-containing material may successfully be removed using the teaching of Mullee much less Sehgal in view of Mullee.

In addition, considering Sehgal and the unreasonableness that one skilled in the art would select the accelerator PLUS the aqueous fluoride from the list of seven optional genus', and then select the lower alcohols from the list of five possible accelerator sub-species, it is even more unreasonable that one skilled in the art would look to Mullee for a different lower alcohol than those disclosed in Sehgal (e.g., methanol and ethanol). This lack of objectivity suggests that the rejection is based solely on hindsight, which is impermissible.

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In conclusion, it is not reasonable for one skilled in the art to consider Sehgal and Mullee and select just the components in applicants' claim 6. Moreover, because both Sehgal and Mullee relate to the removal of organic materials only, one skilled in the art could not consider Sehgal in view of Mullee and reasonably expect the successful removal of silicon-containing material. Accordingly, applicants request withdrawal of the rejection of claim 6 as being obvious in view of Sehgal and Mullee.

3. In the July 13, 2007 Office Action, claims 11-13 are rejected under 35 U.S.C. §103(a) as being unpatentable over Sehgal in view of Wilkinson et al. (US 5,789,505) (hereinafter Wilkinson). Applicants traverse such rejection.

Claims 11-13 directly or indirectly depend from claim 1, which as discussed hereinabove, is non-obvious in view of Sehgal. Wilkinson does not cure this deficiency.

Wilkinson relates to the use of surfactants in applications using liquid/supercritical CO₂. In short, Wilkinson discloses a family of surfactants which have been identified as soluble in liquid/supercritical CO₂ and have surface active properties.

Considering Sehgal and the unreasonableness that one skilled in the art would select the accelerator PLUS the aqueous fluoride PLUS the surfactants from the list of seven optional genus', and then select the lower alcohols from the list of five possible accelerator sub-species, and then select the non-ionic surfactants from the list of four possible surfactants, it is even more unreasonable that one skilled in the art would look to Wilkinson for acetylenic alcohols and diols. This lack of objectivity suggests that the rejection is based solely on hindsight, which is impermissible.

In conclusion, it is not reasonable for one skilled in the art to consider Sehgal and Wilkinson and select just the components in applicants' claims 11-13. Accordingly, applicants request withdrawal of the rejection of claims 11-13 as being obvious in view of Sehgal and Wilkinson.

Conclusion

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Based on the foregoing, claims 1, 5-7, 9, 11-14, 39, 41 and 42 are in form and condition for allowance. If any additional issues remain, the Examiner is requested to contact the undersigned attorney at (919) 286-8000 to discuss same. Authorization is hereby given to charge any deficiency in applicable fees for this response to Deposit Account No. 13-4365 of Moore & Van Allen PLLC.

Respectfully submitted

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